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May 24, 1993

Dear LOTAS, ITACCS Members,

Enclosed is the 8th Quarterly Report for the ONR project No. N00014-91-J-1540.

Please let me have your comments and suggestions.

Sincerely yours,

Colin F. Mackenzie, M.D.
Professor and Vice-Chairman
Department of Anesthesiology

NAVY 8TH QUARTERLY REPORT

Between February 1, 1993 and April 30, 1993 we have:

1. video-taped 27 additional cases in Shock Trauma (total tapes = 85 through May 1st). continued observational coding of tapes with regard to anesthesiology team activities, decision making in relation to our putative decision trees, verbal communications among team members, and subjective ratings of stress,
2. dealt with several equipment problems, upgraded our data acquisition software, enhanced the audio recording system in several of our data acquisition bays, and developed a means of more readily obtaining hard-copy plots of patient physiological data from which to identify periods of particular interest for video analysis of anesthesiology team behavior,
3. refined our data collection procedures for subjective ratings of stress; developed a means for facilitating the transcription of data analysis interviews with subject matter experts (SMEs). These audio transcriptions are typed into Word Perfect files and now can be transferred into the OCS Tools format used for observational coding data,
4. proceeded with data analysis on several fronts -- a) examined our subjective stress rating data with neural network and multiple regression approaches (Attachment #5), b) examined the data from our post-trauma questionnaires with correlational analyses, c) continued to code taped cases involving intubation for verbal communications among team members, d) worked with LOTAS group anesthesiologists in the development of a decision tree for emergency intubation with the intent of expanding this into a process model, e) did some preliminary curve fitting of physiological data that may assist our analysis of pattern recognition and its relation to decision-making (Attachment #2), f) identified differences between hand-written and automated records of physiological data-acquisition,
5. flowcharted our data collection software and both data acquisition and data analysis processes, in preparation for two papers on these topics to be submitted to refereed scientific journals (Attachment #1),
6. presented a paper at the "Human Performance and Anesthesia Technology" conference in New Orleans and a progress report at the ONR contractors meeting on "Stress and Performance" in Bethesda, Maryland,
7. submitted a paper titled "Video Analysis of Two Emergency Tracheal Intubation Cases Identifies Errors and Inappropriate Decision-making" to <u>Anesthesiology</u>. Had a topic analysis of error in complex decision making tasks accepted for panel presentation and publication at the Human Factors Society (Attachment #4),
8. made contacts with Jens Rassmussen in Denmark, Kent Norman in College Park Maryland and Judith Orasano's group at NASA-Ames, and received numerous other inquires from researchers in Italy, Canada, Chile, and Denmark.

Continued Data Collection and Initial Video Analysis

The three Undergraduate Research Assistants (URAs) who were hired during the last quarter have facilitated data collection in Shock Trauma. Their presence on-site, and coverage during evening and weekend hours when trauma admissions are most prevalent, has afforded us

better access to the most interesting cases. They routinely check for equipment failures or disconnections. Incidents of equipment sabotage, which had plagued the project earlier, have now decreased. With the URAs being housed in Shock Trauma's office space, the project has also gained better access to the on-shift anesthesiologists who are serving as subject matter experts (SMEs) for video analysis. Consequently, the turn-around time from initially taping a case until completion of a data analysis pass with the anesthesiologist who was taped has decreased. We are striving to further reduce this turn-around time, and there continues to be a significant backlog of work in transcribing and coding the audio taped video analysis sessions with SMEs into OCS Tools.

Equipment and Software Upgrades

A VCR and an audio system power supply have failed during this quarter. Both have been repaired and are back on-line.

We upgraded our data acquisition systems in order to read blood oxygen saturation (SaO_2) and end tidal CO_2 through the Mennen monitoring system that provides us with the other patient physiological data. SaO_2 and ET-CO_2 are captured by a Nellcor monitor which now communicates that data to the Mennen. Having these measures available more reliably in our automated data log, and on the video overlay that is being recorded to tape, will aid in interpreting a number of cases.

We have been experimenting with ways to improve the audio recordings that we have been obtaining in Shock Trauma. In two of the bays we have added a second microphone and a mixer to integrate the outputs of the two into a single channel that is taped. We have also tried mounting this second microphone in several different ways in order to maximize coverage of the workspace for picking up voice, while minimizing the pickup of equipment noise. The arrangements with two microphones seem to provide better quality recordings of anesthesiology team verbal communications.

We have also facilitated the means for obtaining hard-copy plots of the patient vital signs (physiological) data that are logged to disk by our data acquisition systems. These data are captured in real-time from the Mennen monitoring system that presents displays to the trauma team, and then, at the end of a case, are transmitted automatically across a campus network to the lab. Here the files pass through a sequence of steps that reformat the data into a form that is compatible with the Paradox data-base that stores our other types of data. The recent enhancement allows these files to be ported to a Macintosh computer system and plotted onto hard-copy. Patient physiological data are now being plotted routinely for reference during the video analysis process. This will facilitate future analyses relating trauma team performance to the LOTAS decision trees, which hypothesize certain treatment interventions being tied to abnormalities in patient vital signs.

Changes to the Video Analysis Process

We have revamped our methods for interviewing anesthesiologist SMEs. Previously, we had been collecting and coding various types of data from SMEs in separate passes -- (A)

subjective ratings of stress and general commentary by participant SMEs, (B) subjective ratings of stress and general commentary by non-participant SMEs, (C) verbal communications transcription and coding, (D) coding of anesthesiologist activities, including intubation milestones and activities, based on SME commentary. We had not been routinely interviewing SME's about the decision trees (although selected tapes had been reviewed by Dr. Mackenzie with this in mind) and the coding of other team activities had been done only sporadically. Moreover, we had come to realize that the instructions for the stress ratings were somewhat ambiguous with regard to whether we wished the ratings to reflect the potential or perceived stressfulness of the case conditions, and we were obtaining these ratings only every five minutes.

During the past quarter we implemented several changes in procedures, involving how we utilize the SMEs, what instructions we give them, and how we code their inputs. We now are attempting to get all relevant input from SMEs in a single session -- this involves having them provide a running commentary of the team's <u>activities</u> and <u>highlights</u> of patient treatment, with pauses every minute during the periods surrounding induction/intubation (instead of every five minutes) for subjective ratings of stress, commentary about how their activities relate to the decision trees, and (for the SMEs who actually participated in a given case) introspections about their decision-making processes at the time. Stress ratings now consist of the six scales we have been using, with more explicit instructions to rate these factors as <u>stressors</u> (i.e., characterizing the conditions of the case; the potential for inducing stress), and with the addition of a seventh scale, which is explicitly rated in terms of <u>perceived</u> (i.e., experienced) <u>stress</u>. We are obtaining subjective ratings every one minute during the period from 10 minutes before the start of induction/intubation until 10 minutes after the end of intubation. During other periods, we are still obtaining subjective ratings every 5 minutes, as before.

The coding of these data into OCS is still done in separate passes as before, but with the activity coding now integrated in the passes during which commentary and subjective ratings are coded. The communications coding is still done separately. In that it has proven to be an inefficient use of the SME's time for us to try to code into OCS while the SME is present, we are now simply audio taping the SME's comments and ratings, and then subsequently coding this information into OCS. SME session coding can either be done with reference concurrently to the video and audio commentary tapes, or by transcribing the audio commentary first and viewing the video with this transcription in hand. If a transcription has already been done, the coding pass need only involve associating appropriate time stamps and codes with each entry in the transcript. A custom C program is used to merge the two.

At the points at which the playback of the tape is paused for the SME to give subjective ratings, the SME is also now asked to address the decision trees. If appropriate, they are to comment as to whether or not, at this point in the case, the treatment reflects the courses of action envisioned in *any* of our *decision-trees*. If so, they describe where the team is at on the tree (or whether the behavior being observed, in fact, corresponds to any actions presently incorporated in the tree), and what *contingencies influenced the choice of treatment* at this stage of the case. We are interested both in whether a tree is executed when the hypothesized physiological trigger points suggest that it should have been, as well as when activities modeled in the trees are executed otherwise.

Also at these pause points, the SME, when analyzing a tape of a case in which they participated, are asked to comment on his/her *thought processes* and introspect about the *contingencies* that influenced the decision-making and chosen *courses of action*. They are asked to consider patient signs, instrument readings, what they knew about the case at various times, what they didn't know, their experience, team interactions, and other mitigating factors.

Data Analysis Progress

Neural Network Stressor Analysis Data analysis is progressing nicely on several fronts. Peter Hu has taken the lead on an analysis of the subjective stress rating data using neural network and multiple regression approaches. An abstract submitted to Anesthesiology is attached (Attachment #5). Using data collected as described above, these analyses attempt to weight the ratings of stressors along six dimensions in order to predict the rating of overall perceived stress. Preliminary analyses suggest some advantages of the neural network approach and are showing strong statistical significance in the ability to predict perceived stress. Time stress and information uncertainty tend to be the most heavily weighted factors. Additional analyses are now focusing on individual differences among the ratings by different anesthesiologists. Mr. Mahaffey has taken the lead in examining the data from our post-trauma questionnaires with correlational analyses. We have continued to code our video taped cases involving intubation for verbal communications among team members, and Dr. Horst has taken the lead in analyzing these data. A subset of the LOTAS group anesthesiologists are proceeding in the development of a decision tree for emergency intubation. After this has been developed into a decision tree and contingencies affecting the decision points have been explicated, we plan to expand this analysis into a process model using MicroSAINT and attempt to predict the times required (and methods chosen) for various teams observed on tape to reach specific milestones in the intubation process.

Physiological Data Plots - Curve Fittings

We have also used our abilities to plot physiological data that is automatically collected to examine the linear and non-linear models that best fit the changes in blood pressure and heart rate (Attachment #2). For example, there may be relationships between decision-making and points where data diverge from the linear fit, e.g. point A on Attachment #2. Alternatively, experts may have better pattern recognition and identify trends that require intervention earlier. The point B on the non-linear curve of the same data is such a point where there is a large discrepancy between the linear and non-linear data. While speculative, it is interesting to note, however, that the acute rise in systolic blood pressure at point A in Attachment #2 does represent the trigger point for entering our hypotension decision tree. The anesthesiologist ordered a bolus infusion of fluid from the rapid infusion technician at the moment when systolic blood pressure fell to 102 and the acute rise in blood pressure at point A is the response to this fluid infusion.

Physiological Data Plots - Automated Data Collection vs. Handwritten Record

Attachment #3 compares the handwritten records (upper panel) to the automatically collected data from the monitor interfaces. There is clearly considerable discrepancy. We will

examine these discrepancies and see whether they are associated with workload, low stress ratings, or other factors obtained from the video analysis.

Papers and Presentations

The URAs and Peter Hu have flow-charted the current versions of the physiological data acquisition programs and automated data processing (see Attachment #1). This information will be incorporated into two methodological papers that we are writing for submission to refereed scientific journals. The paper entitled "Video Analysis of Two Emergency Tracheal Intubations Identifies Errors and Inappropriate Decision-making" has been submitted for publication. It is likely that additional papers will be written up in the coming quarter on the topics of verbal communications among the anesthesiology team, neural network analysis of the subjective ratings of stress, and the development of a decision tree for emergency intubation.

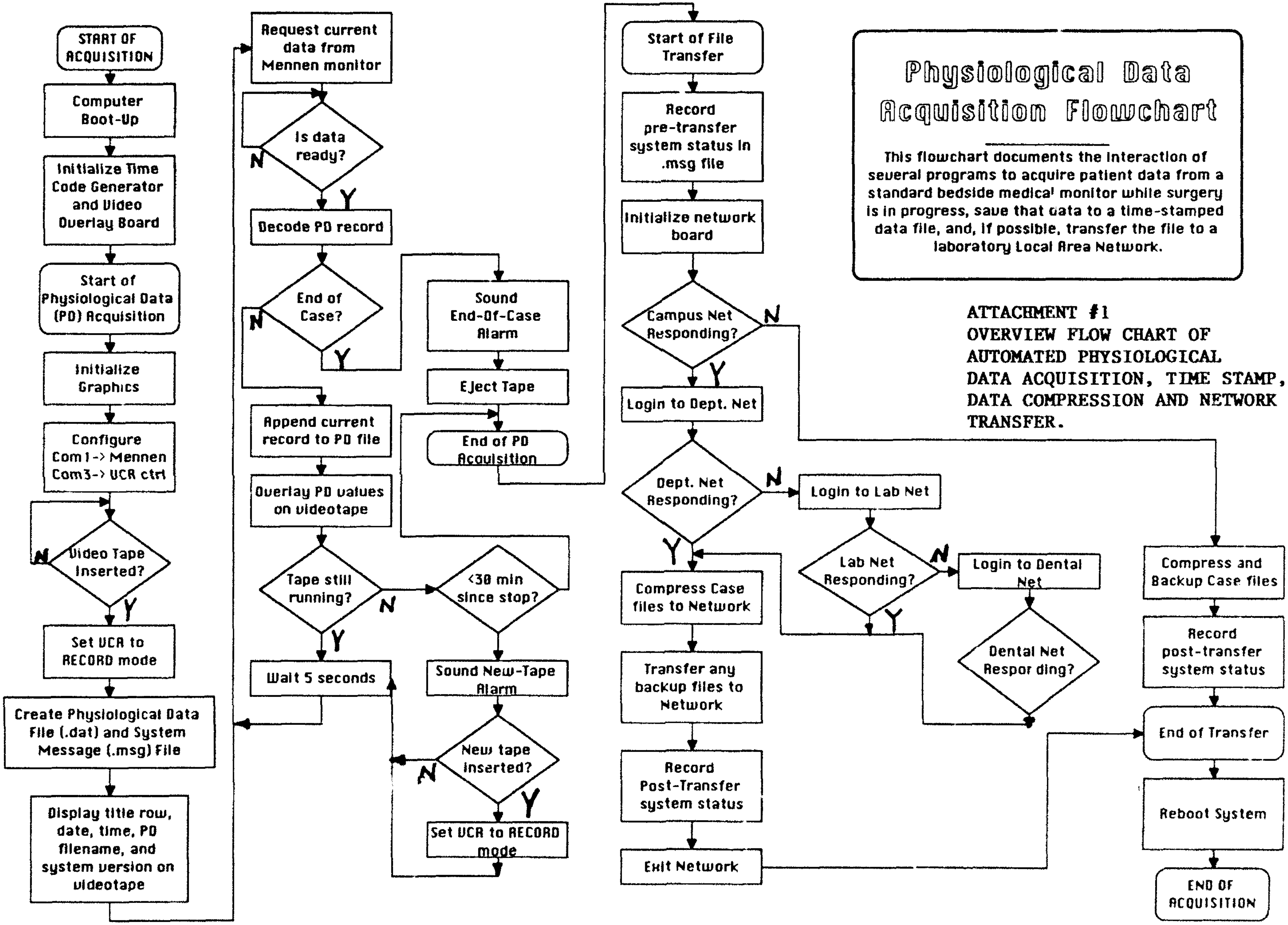
Dr. Mackenzie and Dr. Craig each presented a paper at the "Human Performance and Anesthesia Technology" conference in New Orleans in February, 1993 and a progress report to the ONR contractors meeting on "Stress and Performance" in Bethesda, Maryland in April, 1993. In the coming quarter, Dr. Mackenzie, Dr. Forrest, and Dr. Horst will be presenting papers related to the present project at the International Trauma Anesthesia and Critical Care meeting in Baltimore, MD (May, 1993; hosted by the University of Maryland at Baltimore) and Dr. Horst will be presenting a paper at the Cognitive Science Society meeting in Boulder, Colorado in June, 1993. Dr. Mackenzie will be presenting a paper at the Human Factors Society in Seattle, Washington in October and will be on a panel with Doctors Gary Klein, Judith Orasano and Randy Mumaw. His presentation is titled "Group Decision-Making during Trauma Patient Resuscitation and Anesthesia" (Draft paper enclosed as Attachment #4). Several abstracts have been submitted and are under consideration for possible presentations at other upcoming conferences.

Contacts with an Interest in the Program

Dr. Jens Rasmussen has expressed an interest in reviewing some of our data. We have recently obtained permission from the LOTAS Group for selected video tapes to be sent out to Dr. Rasmussen and others for review. There is a group at Riso National Laboratory, Denmark consisting of Doctors Andersen, Ording, Jensen and Pedersen who are working with the Human Factors Group at Riso. Dr. Paul Milgram and Mr. Yan Xiao at the University of Toronto, Department of Psychology will also receive some tapes for their comments. Dr. Judith Orasano of NASA-Ames has already received one tape and copies of our decision trees and we have been in E-mail contact regarding our mutual interests. Dr. Kent Norman and University of Maryland College Park, Department of Psychology will also be reviewing tapes and providing some suggestions and exploring avenues of collaboration. Dr. Marzio Mezzetti and colleagues at the Postgraduate School of Anesthesia and Resuscitation in Pavia, Italy have expressed a wish to participate in the review of video tapes as has Professor Herman Delooz, Chief of Emergency Medical Services Systems in Leuven Belgium and Professor Guillerino Lema, President of the Chilean Society of Anesthesiology. We anticipate additional input to our analysis and suggestions for further study to occur as a result of these cooperative efforts.

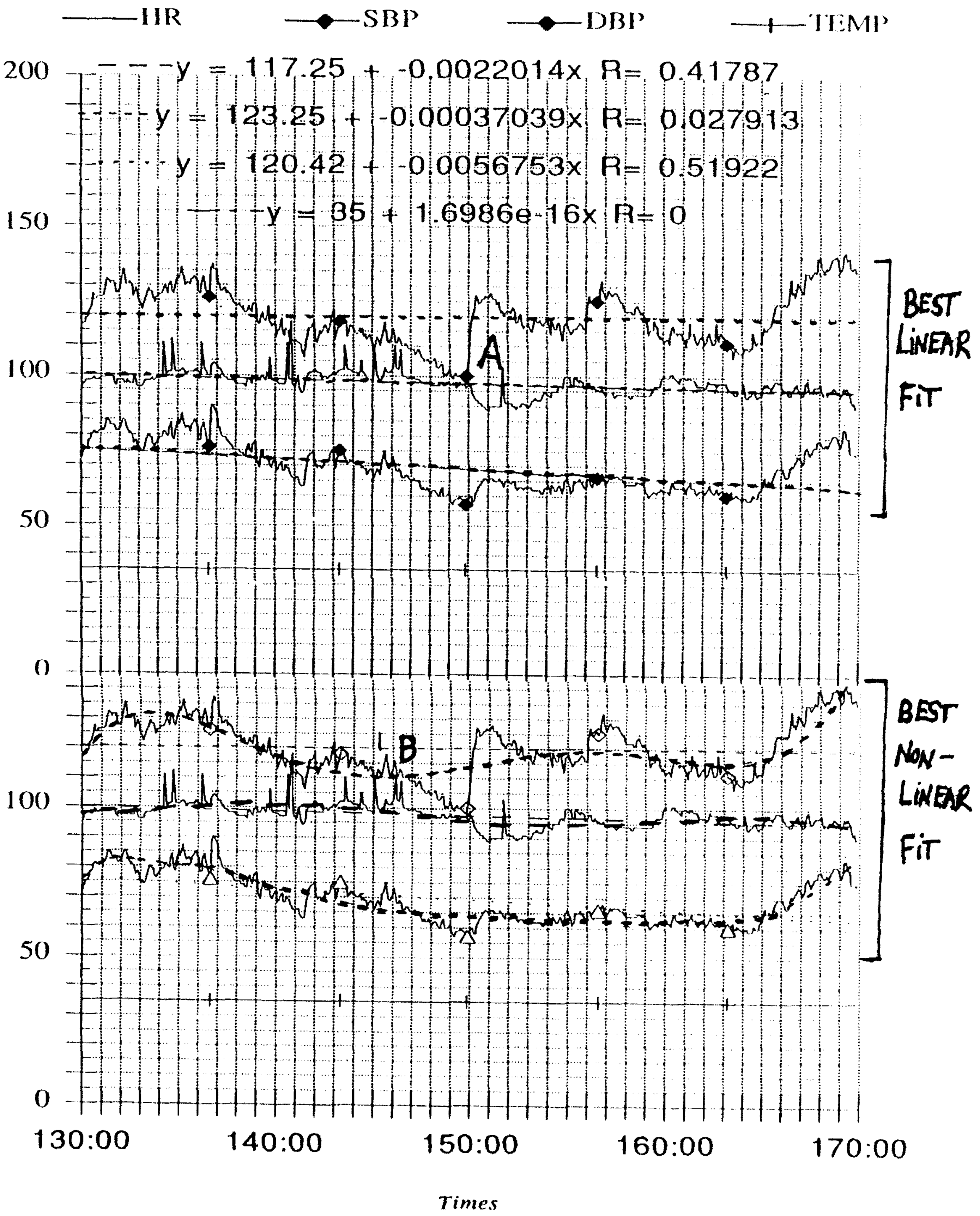
Physiological Data Acquisition Flowchart

This flowchart documents the interaction of several programs to acquire patient data from a standard bedside medical monitor while surgery is in progress, save that data to a time-stamped data file, and, if possible, transfer the file to a laboratory Local Area Network.

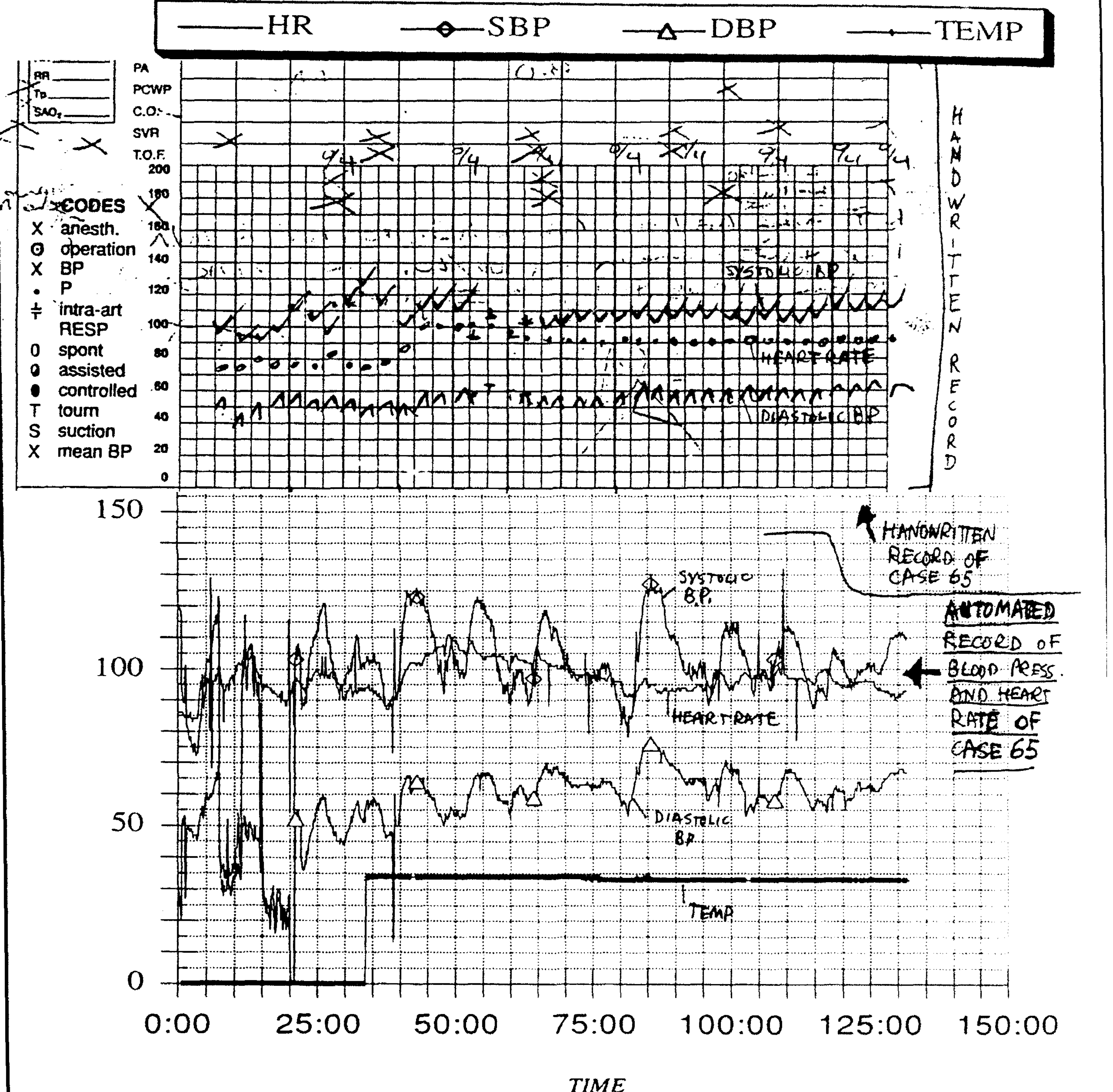


ATTACHMENT #1
OVERVIEW FLOW CHART OF AUTOMATED PHYSIOLOGICAL DATA ACQUISITION, TIME STAMP, DATA COMPRESSION AND NETWORK TRANSFER.

CS086(130-170 min)



CASE 65



NOTE DISCREPANCIES IN HANDWRITTEN AND AUTOMATED RECORD OF BLOOD PRESSURE AND HEART RATE. PARTICULARLY NOTE DIFFERENCES FROM 60 minutes – 125 minutes

Abstract

We examined decision making in the real world environment of trauma patient resuscitation and emergency anesthesia in a level one Trauma Center. The objective was to analyze performance under stress and to systematically study the cognitive and behavioral effects of various stressors (time pressure, information uncertainty, task workload, fatigue and trauma team incompatibilities) and examine coping strategies that proved effective. Our focus was the trauma anesthesiology team who secure and manage the airway, provided adequate ventilation and optimize cardiorespiratory function. The intent is to develop a process model of such decision-making performance that may generalize to other team performances under stress.

The data was analyzed from video-recordings of real resuscitation and trauma anesthesia from the Level One Trauma Center. Video and audio recordings were accomplished with turn-key systems that also encode vital signs from the patient. Video analysis was conducted on a separate work station in conjunction with the trauma anesthesiologists. Decision-trees were developed for management of abnormalities in patient physiological data. These flow charts of decision-choice points, alternative interventions and contingency information were compared with what actually occurred in real-life. The videotapes were viewed by the participants and other non-involved anesthesiologists shortly after acquisition. Subjective stressor scores and identification of tasks and workload were carried out. Commentaries and vital signs were time stamped to ensure synchronization. Implementation of a decision tree occurred when physiological variables became out of range. During video analysis the participants underwent a structured interview to identify choices, factors mitigating the choice and whether other decisions not in the tree were considered.

We believe that these decision trees do in general provide a useful structure to define performance especially in task specific situations such as tracheal intubation. As a result of video analysis we have identified situation-specific factors that should be included in modified decision trees. It is apparent that individuals experience and training markedly influences performance. Inexperience results in an additional stressor at least as salient as those already identified. Uncertainty appears more stressful than task workload per se. Video analysis has also revealed several instances in which clearly inappropriate or non-optimal decisions were made, leading to implications for training. Preliminary results of video analysis indicate that there are systematic differences in verbal communications during periods entailing different levels of stress, between management of high and low severity of injury patients and during emergency compared to elective tracheal intubation.

Group Decision-Making during Trauma Patient Resuscitation and Anesthesia

ATTACHMENT #4

Draft paper for presentation at Human Factors Society October 1993 Seattle Washington.

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Introduction

We examined decision making in the real world environment of trauma patient resuscitation and emergency anesthesia in a Level One Trauma Center. The patient is met by a multidisciplinary team of trauma specialists on admission by helicopter or ambulance from the scene of injury. The patient is resuscitated and may undergo surgery and critical care. The trauma team which includes a different mix of personnel from case to case, must communicate effectively and perform a number of clinical tasks efficiently, often under severe time pressure. Trauma is unique to each individual patient so the extent and sites of traumatic injuries are unknown when the patient is first seen. This is therefore a fascinating environment in which to study team performance and decision making under stress in naturalistic conditions.

The overall goal of the present project is to systematically study the cognitive and behavioral effects of various stressors that can affect decision-making performance in this environment and the coping strategies that prove effective. The stressors of interest, in addition to time pressure and information uncertainty, include task workload (related to the severity of the patient's injuries and thus the number of clinical tasks that are competing for attention), fatigue, and team incompatibility. Our focus has been on the trauma anesthesiology team, who are responsible for maintaining the airway, providing adequate ventilation and anesthesia. The intent is to develop process models of the decision-making performance of the trauma team(and, in particular, the lead anesthesiologist). Such models should prove useful in developing training strategies for trauma anesthesiology and may generalize to other team performance settings in which the same stressors are operative.

Methods

The starting point for the modeling process is a set of decision trees that have been developed by the Level One Trauma Anesthesia Simulation (LOTAS) group at the University of Maryland at Baltimore. Because the efficacy of resuscitation and anesthesia for trauma patients depends heavily on restoration and maintenance of abnormal physiological parameters to normal ranges, the decision trees are based on various physiological abnormalities--tachycardia, bradycardia, hypotension, hypertension, hypoxemia, hypothermia, hyperthermia, increased end tidal CO_2, decreased end tidal CO_2 and a "Difficult" Airway. Originally developed as clinical protocols these decision trees provide flow charts of decision choice points, alternative intervention strategies, and some contingency information that is typically brought to bear on the decision. Passage of a ventilating tube through the larynx(intubation) is considered by many anesthesia providers to be the most stressful maneuver associated with management of the trauma patient. Emergency intubation is a risky procedure because regurgitation of stomach contents, airway obstruction, inability to ventilate and rapid falls in blood pressure may occur when anesthesia and muscle relaxation are induced in shocked and traumatized patients. We therefore compared these emergency intubations which were performed under stress with the more routine tracheal intubations that precede anesthesia and surgery in the operating room.

Actual performance is observed by video taping trauma treatment in two admitting bays and in two operating rooms at the Maryland Institute of Emergency Medical Systems, Shock

Trauma Center. Video images and sound track were acquired respectively by miniature cameras and microphones suspended from the ceiling of two admitting bays. The audio channel captured communications among the entire trauma team consisting of anesthesiologist(s), nurse anesthetist(s), surgeons, emergency medicine physicians, nurses and technicians. Physiological monitor of patient vital signs were interfaced at each location to a personal computer (PC). The PC supported 1) a timecode generator which writes machine readable time code onto the videotape, 2) a video-overlay processor which allows 5 sec updates of physiological data (heart rate, blood pressure, end tidal carbon dioxide, arterial O_2 saturation and temperature--abnormalities of these variables are described by the decision trees to be displayed alphanumerically on the video image of the treatment environment that is recorded from the ceiling mounted video camera and microphone, 3) a third serial port through which the computer can query the status of the video-cassette recorder (VCR) and 4) a network interface for remotely controlling the system and automatically compressing and downloading data. The incoming physiological data are, therefore, both displayed on the vi 'eo image being taped, in order to facilitate later observational analysis, and logged to a data-base on the computer disk, appropriately time-stamped with the same time code that is written on the video tape. The video acquisition system is configured for turn-key operation in order to be as unobtrusive as possible (although team members have given their consent to be thus observed, and they are aware when a case is being recorded). Video analysis is conducted on a separate workstation, which is also built around a PC and outfitted with a time code reader, VCR controller, video overlay processor, and network interface board, in addition to a VCR and monitor. A software package (OCS Tools, Triangle Research Collaborative) supports observational analysis of the Video tapes. This package allows frame accurate control of the VCR with reference to the recorded time code, coding of the frequency and duration of anesthesiologist behaviors by pressing single keys on the keyboard, and the logging of time-stamped textual notations about the scenarios being viewed. The resulting observational data-base can be quantified by summary statistics and related to the corresponding physiological data-base that contains the patient's vital signs throughout the case.

As soon as possible after a case is taped (usually within several days), a data analyst reviews the tape along with the lead anesthesiologist whose performance was recorded. A structured interview process is used including the subject mater expert (SME) being asked for subjective rating of the aforementioned stressors at five minute intervals of elapsed time on the case . On an ongoing basis, the SME is asked to elucidate the tasks that each team member is involved in and to verbalize, as much as possible in retrospect, what his/her thought processes were with regard to considering alternative treatment strategies. When the tape is paused in order to collect the subjective ratings, the SME is also asked to relate the status of the case to any of the decision trees that are appropriate. When one or more decision trees can be seen as having been operative, the SME is asked to conceptualize the extent to which they considered each choice point, what factors mitigated this choice, and whether other factors not currently represented in the tree came into play. Based on this structured interview, which is itself audio recorded, the data analyst then code the team's task activities and behaviors (with each logged entry being related to the time stamp from the video), along with explanatory notes that describe any behaviors or verbalization that particularly reveal decision-related considerations or team coordination. In addition another knowledgeable anesthesiologist SME who was not involved in the case under examination, also reviews the tape in the same manner and is consulted for

clarification or further explanation about the clinical activities or discussion that is observed from the tape. All participants take a NEO-Personality Inventory (NEO-PI) once and complete a summary questionnaire immediately after each video taping is finished. The NEO-PI, questionnaire, stressor scores and physiological data are stored in a PARADOX relational data base.

Of particular interest in our ongoing exploratory analyses are the following issues:

- the extent to which the clinically derived decision trees offer a structure within which to describe both individual and team performance; a related matter is how individualized or situation-dependent are the intervention strategies by which various practitioners function in this environment.

- the extent to which these decision trees are comprehensive and accurate both in terms of the intervention option at various choice points in a scenario, and in terms of the contingencies that influence the choices.

- the extent to which performance, thus conceptualized, is influenced by stress; i.e., what stressor are most salient?

- what strategies are most effective in mitigating the encumbering effects of stress, or various stressors?

- A comparison of communication and subjective stressor ratings between emergency and elective tracheal intubation, high and low injury severity and correlation with the summary questionnaire and NEO-PI.

Results and Discussion

Thus far we have chosen to focus on cases involving tracheal intubation. Emergency intubation is task that is inherently stressful because of the likelihood of critical events occurring. Intubation can be accomplished by an number of different strategies, particularly when the airway is occluded. Therefore, we thought that the activities involved in intubation might be especially sensitive to the stressors of interest.

Analyses are still ongoing and we hope to have quantitative data to present at the conference. However, several preliminary conclusions can be drawn:

- the decision trees, in general, do provide a useful structure to define performance especially in task specific situations such as tracheal intubation.

- there are a number of situation-specific factors that need to be reflected in the present trees to make then more comprehensive.

- the individual's experience and training markedly influence performance; lack of experience in dealing with particular clinical problems or instrumentation can be seen as

a stressor that is at least as salient as the stressors that we had identified a priori.

Video analysis have revealed several instances in which inappropriate or non-optimal decisions were made including hazards to the patient due to 1) inexperienced airway management, 2) information uncertainty leading to inappropriate decisions, 3) unfamiliarity with equipment, 4) impaired judgement due to stress and 5) failure to use available monitors that could have minimized patient hazards and simplified decision making. Fortunately none of these errors adversely affected patient outcome.

We have now accumulated a sufficient number of cases involving intubation that we can make comparisons between elective and emergency situations and among cases involving different types and levels of stressors. We are in the process of coding these cases with respect to the task-related activities that can be observed to characterize the team's performance. These observed activities will be compared and contrasted with expert judgements of the various treatment activities that could have been considered at various junctures during a case. Alternative task activities will then be quantified with respect to the frequency with which various treatment activities and options were pursued, the time to accomplish various milestones in treatment, and the choices that were made regarding shedding or sharing (i.e., delegation) of competing tasks. These quantitative data will be related to the judged levels of stressors in an attempt to better derive the effects of stress on performance. If feasible, such results will be incorporated into a process model of induction/intubation performance patterned after the decision tree flow diagrams.

ATTACHMENT #5

TITLE: STRESSORS OCCURRING DURING EMERGENCY TRACHEAL INTUBATION

AUTHORS: P.F. Hu MS, C.F. Mackenzie MD, R. Horst PhD, P. Martin MBChB, C Boehm MD, F. Forrest MBChB, W. Bernhard MD and the LOTAS Group.

AFFILIATION: Department of Anesthesiology, University of Maryland and Maryland Institute for Emergency Medical Services Systems (MIEMSS) and Man-Made Systems Baltimore, MD 21201

INTRODUCTION: Emergency tracheal intubation is a stressful maneuver yet little is documented about the stressors that occur. We examined videotapes of real-life emergency tracheal intubation occurring in the admitting area (AA) of a level one trauma center to identify potential stressors. We used a mathematical model to determine among the assessed stressors whether there was any additional bias factor not identified and to provide relative weights between the assessed stressors and an overall stressor score. We postulated that identification of such stressors and their relative weights may facilitate development of training and coping strategies and ultimately improve performance of emergency intubation.

METHODS: Videotapes were acquired by miniature cameras suspended from the ceiling of two AAs. The field of view included the anesthesia team. The audio channel captured team communications from ceiling microphones. The physiological monitors were interfaced to a personal computer (PC) that included video overlay technology. An anesthesiologist with experience in trauma patient airway management(TA) viewed the video tapes within a few days of the emergency intubation. Every 1 min the TA scored 6 stressors (S1-S6), (noise, non-anesthesia team interactions, anesthesia team interactions, time stress, task workload, diagnostic uncertainty) on the basis of all previous experiences with emergency airway management using a 5 point scoring system (1= a lot less stress than usual, 2= a little less, 3= typical, 4= a little more, 5= a lot more than usual). The TA also made one overall assessment of stress, S7, at 1 min intervals on the same scale. The stressor scores were modeled using neural networks as follows $S1*W1 + S2*W2 + \ldots + S6*W6 = S7$, where W1-W6 = the relative weights of the stressors S1-S6. Data from nine video tapes including 174 stressor scores were combined randomly into 75%(n=131) used for training a modified single layer neural networks(N.N) and 25%(n=43) for testing N.N prediction of the overall stressor score S7. N.N was initialized with different training steps and starting weight vectors, then iterated until, after filtering, the data provided the minimal error weight vector(MEW). Testing N.N to predict S7 used MEW. Correlation coefficient(r) and % error were calculated by comparing the predicted and real overall stressor(S7).

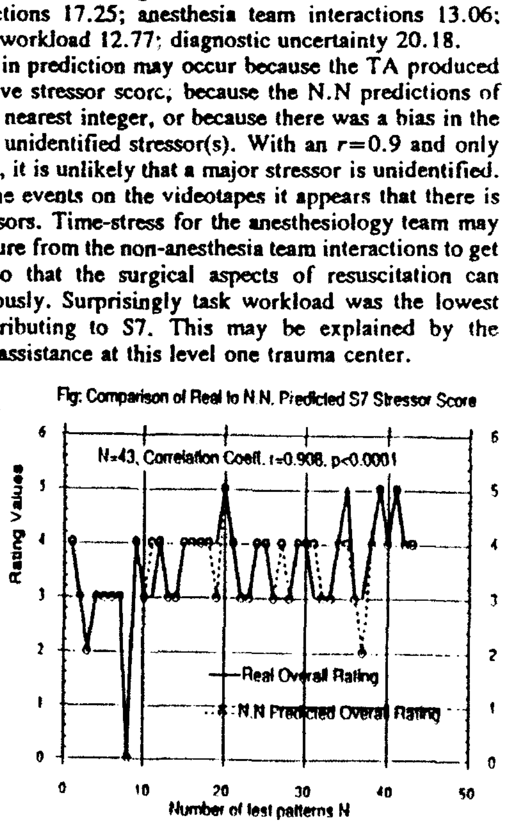
RESULTS: The data from nine patients produced an 86.05% accurate prediction of S7 scores after N.N training (r=0.908 p<0.0001 see Fig). The maximal predicted error=1 (predicted-actual S7). The relative weights(%) of stressors contributing to S7 were: noise 13.74; non-anesthesia team interactions 17.25; anesthesia team interactions 13.06; time-stress 23.00; task workload 12.77; diagnostic uncertainty 20.18.

DISCUSSION: Error in prediction may occur because the TA produced a contradictory subjective stressor scorc, because the N.N predictions of S7 were rounded to the nearest integer, or because there was a bias in the stress scores due to an unidentified stressor(s). With an r=0.9 and only 131 data training points, it is unlikely that a major stressor is unidentified. From examination of the events on the videotapes it appears that there is a linkage between stressors. Time-stress for the anesthesiology team may be precipitated by pressure from the non-anesthesia team interactions to get the patient intubated so that the surgical aspects of resuscitation can proceed more expeditiously. Surprisingly task workload was the lowest weighted stressor contributing to S7. This may be explained by the abundance of qualified assistance at this level one trauma center.

CONCLUSION: Strategies to minimize stress of emergency tracheal intubation should include reduced pressure from the non-anesthesia resuscitation team and diminished diagnostic uncertainty by communication of all available information about the patient before intubation.

Supported by ONR Grant #N00014-91-J-1540

Fig: Comparison of Real to N.N. Predicted S7 Stressor Score



Group Decision-Making during Trauma Patient Resuscitation and Anesthesia

ATTACHMENT #4

Draft paper for presentation at Human Factors Society October 1993 Seattle Washington.

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SUPPLEMENTARY

INFORMATION

Errata AD-A265 545

DEPARTMENT OF THE ARMY
UNITED STATES ARMY WAR COLLEGE
CARLISLE, PA 17013-5050

25 June 1993

AWCSL

MEMORANDUM FOR DEFENSE TECHNICAL INFORMATION CENTER, BLDG #5, CAMERON STATION, ALEXANDRIA, VA 22304-6145

SUBJECT: Replacement Page for Student Paper

1. Enclosed are 2 copies of replacement pages for student paper DTIC number AD-A265 545, titled "Evolution of the Armoured Force 1920-1940:" author: E. OShaughnessy.

2. Original documents were sent to DTIC on May 10, 1993, on May 27, 1993 item was received back from DTIC with the above cited DTIC number.

3. Please make the necessary corrections or remove page number 58 and insert corrected page 58 to your copies of this document and discard original pages as they are no longer valid.

4. Any questions may be directed to Lillie Cramer, DSN: 242-4317 or Coml: 717-245-4317. Thank you for your assistance in this matter.

Margarete M Rice

Encl

MARGARETE M. RICE
Chief, Collection Development

Experimental Force was in being he had been sent TDY to Fort Meade for the entire period. He was considered absolutely essential to the success of the Mechanized Force because of his unmatched experience.

31. Johnson, p. 165.

32. Major Levin H. Campbell, Jr., "A New Weapon of Warfare - the Mechanized Force," The Infantry Journal, April, 1929, pp. 359-365.

33. Major Ralph E. Jones, "Shall We Armor or Mechanize?," The Infantry Journal, July, 1929, pp. 54-55.

34. Major C. C. Benson, "The New Christie, Model 1940," The Infantry Journal, September, 1929, pp. 255-261.

35. Major Ralph E. Jones, "Our Tanks," The Infantry Journal, December, 1929, pp. 594-600.

36. Lieutenant Dache M. Reeves, "Organization and Composition of a Mechanized Force," The Infantry Journal, December, 1929, pp. 612-618.

37. Major Sereno E. Brett, "Tank Reorganization," The Infantry Journal, January, 1930, pp. 28-32.

38. Major G. S. Patton, Jr., and Major C. C. Benson, "Mechanization and Cavalry," The Cavalry Journal, April, 1930, pp. 374-376.

39. Lieutenant Colonel K. B. Edmunds, "Tactics of a Mechanized Force: A Prophecy," The Cavalry Journal, July, 1930, pp. 410-417.

40. Correspondence, Office Chief of Infantry, Box 92, Record Group 177, NA.

41. Captain Arthur Wilson, "The Mechanized Force: Its Organization and Present Equipment," The Infantry Journal, May-June, 1931, pp. 253-254.

42. Gillie, p. 36.

43. Captain Arthur R. Wilson, "With the Mechanized Force on Maneuvers," The Infantry Journal, July-August, 1931, pp. 331-335.

44. Grow, p. 15.

45. In 1942, more than ten years after Benson argued for the creation of armored divisions he would be the Chief of Staff of the 1st Armored Division in North Africa. He would retire as a Colonel in 1950.